Experimental observation of ruptures propagating on heterogeneous interfaces

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We present experimental observations of a propagating rupture interacting with one or several mechanical heterogeneities. We developed a friction laboratory experiment where a soft elastic solid slides past a rigid flat plate. The system is coupled to an original medical imaging technique, ultrasound speckle interferometry, that allows observing the rupture dynamics along the interface as well as the emitted elastic shear wavefield into the solid body. We compare the dynamics of propagating rupture for an homogeneous flat interface and for three cases of heterogeneous sliding surfaces: 1) an interface with a single point-like barrier made of a small rock pebble, 2) an interface with a single linear barrier that joins the edges of the faults in a direction perpendicular to slip 3) an interface with multiple barriers disposed on half of its surface area, creating an heterogeneous zone.

We obtain experimental observations of dynamic effects that have been predicted by numerical dynamic rupture simulations and provide experimental observations of the following phenomena: a barrier can stop or delay the rupture propagation; a linear single barrier can change the rupture velocity, increasing or decreasing it; we observe transition from subshear to supershear propagation due to the linear barrier; a large heterogeneous area slows down the rupture propagation.

We observe a strong variability of the rupture dynamics occurring for identical frictional conditions, that we impute to memory effects caused by the heterogeneity of the stress field due to both the loading conditions and the remaining stress field due to previous rupture events.

These experiments therefore confirm previously reported numerical simulations of ruptures along heterogeneous interfaces. When comparing with natural observations or earthquake ruptures, our data provide some phenomenological insights to explain the complexity of the rupture history inferred from the pattern of seismic radiations.

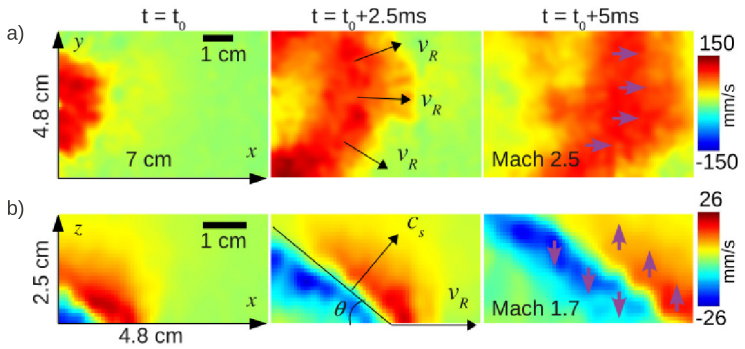

Figure 1: a) observation of a supershear rupture propagating on a homogeneous interface and b) observation of the shock wave radiated by a supershear rupture